Neoproterozoic environmental conditions: a novel metal stable isotope perspective

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The Snowball Earth hypothesis proposes that the Neoproterozoic was punctuated by several global low latitude glaciations. This era further witnessed the most significant rise in environmental oxygenation. Moreover, the relationship between the termination of Cryogenian glaciations and the evolution of complex multicellular life has led to debates whether these glaciations might have catalysed and promoted the diversification of life.

To shed light on these post-glacial environmental conditions, we use carbonate sediments of the Witvlei Group, Namibia, that were deposited following the Sturtian (ca. 717-643 Ma) and Marinoan (ca. 635 Ma) glaciations, using a multiproxy approach with an emphasis on novel metal stable isotope systems.

The studied carbonate sections were deposited in intertidal and shallow subtidal/shelf lagoon settings with abundant domical and columnar stromatolites and stromatolite clasts. Shale normalized REY patterns are parallel to modern oxidized seawater with enrichments in HREY over LREY, negative Ce anomalies and superchondritic Y/Ho. $\delta^{13}C$ values are generally 'light' (-2 to -5 ‰) and show no correlations with $\delta^{18}O$ and Sr/Mn arguing against abundant diagenetic overprint. While Fe, V and Cr concentrations show variable but elevated concentrations throughout the studied sections, Cd and Cu concentrations are correlated and constant. First Cr isotope data of carbonates overlying the Sturtian glaciation are in range of bulk silicate Earth (BSE), after which they fluctuate from negative to positive relative to BSE, particularly for post-Marinoan intertidal and subtidal settings with aragonite fans (-0.2 to +0.3‰), while shallow subtidal settings with abundant lithified stromatolites show pronounced positively fractionated $\delta^{53}Cr$ values (up to +0.7 ‰).

We propose dynamic post-glacial redox environments influenced by high nutrient input and biological activity in these shallow seawater settings.